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AN ECONOMIC ANALYSIS OF PRODUCTION AND MARKETS: THE POST AND POLE SECTOR IN MONTANA

by

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and
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I. Introduction

An economic history of Montana's wood-using industry would show two distinct trends in the supply of raw materials. Overtime, an increasing number of native tree species have become commercially significant. Second, corresponding to an expansion of species exploited has been a decrease in the size of trees logged.

In the 1930's, two species were of greatest commercial importance, western white pine and ponderosa pine. During that same time, published reports indicate that timber had to be greater than 24 inches in diameter (dbh) in order to be logged profitably (Baker 1952).

While no parallel estimate of the marginal tree exists for current markets, there is data on average diameters of timber logged in the Northern Rockies. Unpublished data available from the Forest Service Region 1 Office indicates that the average tree diameter logged on Forest Service land in western Montana and northern Idaho 15 years ago was 17 inches. By 1984, the average tree size was less than 12 inches for the same geographic area.

Rather clearly, the days of the large-log wood products economy are already a part of the past. Opportunities to profitably manufacture wood products based upon low raw material costs must ential exploiting exceedingly small diameter timber. In Montana, these opportunities are most often coincident with a prevalent

species, lodgepole pine.

As Benson (1984) indicates, small diameter lodgepole pine is already being processed in Montana and in the Intermountain West. Lumber and plywood manufacturing are moving toward using smaller logs, but post and pole processors utilize the smallest timber. Stands consisting of 5 to 7 inch dbh size classes are the main candidates for post and pole use. The demand for this kind of raw material is derived largely from the demand for post and pole products.

Although considerable time and effort have been spent studying the lumber, plywood and pulp and paper industries, much less is known about the post and pole business. Aside from a basic census of Montana's wood manufacturers (Keegan 1980), very little is known about post and pole production as a separate sector.

The purpose of this study is to improve the descriptive and analytic level of information about Montana's post and pole sector. Many land management problems concern a lack of options for dense, growth-stagnant, small diameter stands of lodgepole pine. Currently, 41% of all softwood growing stock trees greater than one inch dbh on commercial forestland in Montana is lodgepole pine and 30% of the total are lodgepole five inch dbh or less (Green, et.al 1985).

Although the primary impetus for this study arose from land management concerns, the findings are relevant to the performance of Montana's economy. A better understanding of current small diameter post and pole operations and markets could be the basis for expanded production. An improved product market would in turn lead to an improved log market and expanded options for using "problem" lodgepole pine stands.

II. Study Overview

A. Objectives

Given the growing importance of small diameter lodgepole pine as a source of raw materials, it is important to learn about the nature of a sector of the wood products industry with primary production processes based on the utilization of small logs. In Montana, the principal, and virtually exclusive, purchasers of small diameter logs (under six inches in diameter) are post and pole producers.

The specific objectives of this study are as follows:

1. Describe the products and level of production for the sector.
2. Delineate the nature of the firms.
3. Describe the markets and distribution channels.
4. Establish the sources of supply for raw materials.
5. Relate the size of the firms to markets and raw materials.
6. Analyze raw material and finsihed product prices.
7. Estimate sector demand for raw materials.
8. Determine the costs of production.

B. Data collection

Due to the nature of this study and the lack of available information from secondary sources, it was determined that data would be collected directly from post and pole manufacturers. A list of all known post and pole producers in Montana in 1985 was obtained from the Montana Division of Forestry, Department of State Lands. This list constituted the basic frame from which the population for study was drawn.

Forty-three post and pole operations were identified and attempts were made to contact each one. Seventeen of the original list could not be contacted after repeated attempts or were no longer in business. Two did not produce small diameter roundwood products. Twenty-three of the remaining twenty four responded positively to a request for information in the form of a telephone survey (see Appendix A), and one refused to provide information. Thirteen of the participants in the survey sent their price lists for products and raw materials for use in the study.

The profile of the post and pole industry presented in this study is based on a census of all known producers in the state rather than on a sample. Of the pool of twenty-four known producers, only three were excluded from the final analysis. Two of this pool did not provide sufficient information. One producer, the Montana State Prison, was considered to be unrepresentative of the larger industry due to the non-competitive nature of their wage rates and their restricted product market (i.e., state agencies). Another producer owned post and pole operations in two locations and combined their production data. Thus, this study represents an 88% census of known post and pole producers in the spring of 1985.

C. Problems in Measurement

There are a wide variety of post and pole products manufactured in Montana, which in turn, gives rise to a broad range of product prices. This diversity of products and lack of uniform sizes across the sector presents a number of problems in measuring production activities.

Manufacturers reported production in terms of the number of pieces produced. There are no published volume tables available for small roundwood lodgepole pine logs by piece. As the study progressed, it became increasingly apparent that the reporting and analysis of production figures would be facilitated by the development of cubic foot estimates of production volume. Volume measurements are more familiar to people outside the post and pole business and are more comparable to production figures in other sectors of the larger wood processing industry. Thus, rudimentary estimates of cubic foot volume of the products was used as the basis for much of the analysis.

Cubic foot estimates of the small diameter products were completed after consultation with experts in the field of mensuration. A taper factor of 5/8 inch per 8 foot length of raw material was applied to the piece data supplied by post and pole producers. In reporting the number of pieces of each product, respondents to the survey also indicated the average diameter (small-end) and length. The taper figure was used to predict large-end diameter and then cubic volume estimates were calculated based on length and average diameter. No allowances were made for peeling, drilling holes, capping, or pointing of materials.

The lack of standard products sizes is no doubt related to the shape and form of the trees utilized in manufacturing post and pole products. While the lack of cubic volume estimates is a problem from a research perspective, it apparently is of little importance to producers and buyers. For instance, purchasers of fence posts most likely buy posts of a certain diameter and length rather than on the

basis of cubic volume. The number of pieces of a particular size specification is far more important than the volume of wood.

III. Industry Description

A. Products Manufactured

Firms classified as part of the post and pole processing sector produce a variety of roundwood products. Included in this list are posts, poles, rails, props and/or grape stakes, and decorative fencing.

Fence posts not only vary in diameter and length, but in treatment with preservative (i.e, fully or butt treated or untreated). In addition, fence posts may be peeled or unpeeled, and pointed or unpointed. Posts produced for decorative purposes have holes drilled in them, and the number of holes depends upon the number of fence rails to be supported. Jackleg fence posts are manufactured so that pairs stand above ground in a crossed position. These fences are most often used where rocky soil conditions limit digging or driving of fencepost holes.

Like posts, rails come with a variety of options. Those manufactured for decorative fencing have doweled ends to fit post holes. Rails may or may not be treated with preservative and may be peeled or unpeeled. Some gates are manufactured in Montana and are found either assembled or unassembled. Haystack panels and portable corrals are included in the post and rail quantities for a few manufacturers.

Poles are also a diverse product as they include utility poles, barn poles, and miscellaneous others. Tree props and grape stakes are additional products manufactured by several firms.

In addition to roundwood production, some post and pole manufacturers operate small sawmills which produce lumber. Lumber production was not included in the data used for this study. It is of note, however, that this minor degree of integration within the wood products industry has taken place in the post and pole sector.

The prices for the products manufactured by the post and pole industry reflect both the degree of processing and raw material costs. Many manufacturers produced similar products although some were specific to a few manufacturers. As in the case of production volume, the diversity of product prices necessitated the development of a standardized price measure rather than the use of prices reported directly by manufacturers. Thus, a set of price equations were developed as a means of reporting raw material and product prices.

B. The Nature of the Firms

The post and pole sector in Montana is geographically dispersed on both sides of the Continental Divide. Firms are located in seventeen counties.

Post and pole firms range in size from small, part-time operations employing less than one person on an annual basis to larger scale plants with an average annual employment of 45 people. Overall, the sector is characterized by relatively small employment with only two firms employing twenty or more employees and 13 employing six or fewer employees. The average annual employment (including full and part-time) was seven.

The payrolls of post and pole producers ranged from $6000 to $500,000 with an average payroll of $90,500. Reflective of the small

number of employees, thirteen of the producers had payrolls less than $50,000. Table 1 below provides a summary of employment and payroll information.

Table 1
Employment and Payroll Summary--Montana Post and Pole Sector

Employees	Firms	Payroll	Firms*
0- 3	13	$ 6,000- 10,000	3
4- 6	5	$ 11,000- 20,000	2
7-10	1	$ 21,000- 30,000	5
11-20	0	$ 31,000- 50,000	3
20+	2	$ 51,000-199,000	4
		$200,000+	3
Total	21	Total	20

*1 unreported

Information about the capital stock of the post and pole sector was obtained by means of a question (see Question 12, Appendix A) which asked respondents to estimate the replacement value of plant and equipment, including vehicles. As shown in Table 2, the value of the capital stock for more than half of the industry is less than $100,000.

Table 2
Replacement Value of Capital Stock--Montana Post and Pole Sector

Estimated Value	Number of Firms
$ 0 - 20,000	4
$ 21,000- 60,000	4
$ 61,000-100,000	4
$101,000-250,000	3
$251,000-500,000	3
$501+	3
Total	21

Levels of production for the Montana post and pole sector were calculated by converting the information supplied by producers in terms of numbers of pieces for each product into cubic foot volume estimates (see discussion in II.C). Table 3 provides a breakdown for the seven major products manufactured and marketed by post and pole producers.

Table 3
Volume Estimates of Small Diameter Roundwood Products
Montana Post and Pole Sector

Product	Volume, ft3	Percent Total Production
Posts	1,709,947.1	55.6
Poles	359,305.3	11.7
Utility poles	41,637.5	1.4
Barn poles	118,860.3	3.9
Rails	487,021.7	15.8
Props	255,965.4	8.3
Decorative fencing	101,049.4	3.3
TOTAL	3,073,786.7	100.0

Posts not only accounted for the largest volume of production, but were the single small-diameter, roundwood product manufactured by all firms surveyed. Only two firms produced utility poles and barn poles; eight produced decorative fencing; 16 made rails, and 17 made other kinds of poles.

C. The Degree of Competition

Manufacturing is organized competitively in some industries and, at the other extreme, monopolistically in others. A competitive industry is one in which the level of production of any one firm will exert a negligible influence on the prices of products sold or on the

unit costs of raw materials and other factors of production. In contrast, a monopolistic industry represents a form of "price-seeking" behavior. A monopolistic firm is able to govern its production as a means of influencing the price of the products it manufacturers and sells. Likewise, firms which can influence the price paid for raw materials and other factors of production are called monopsonists.

Competition and monopoly are extremes and as such, are useful concepts. However, most manufacturing in the United States is neither purely competitive or purely monopolistic. The degree of competition represents a more realistic way of classifying an industry or sector. In determining the degree of competition, several factors are usually evaluated. Are there barriers limiting new entrants to the industry such as large capital requirements or legal limitations such as patents or licenses? Are there close substitutes for the products? Are there particular brands which evoke consumer loyalties? Finally, is production dominated by a few firms?

It appears as though post and pole manufacturing in Montana is highly competitive by these criteria, although not all of the indicators point in this direction. A rapid turnover of firms was indicated by the number of firms listed in a directory of the industry that were no longer in business or could not be reached by telephone. Coupled with this indication of turnover among producers is evidence of low capital costs for entry into post and pole production. Previous discussion of firm size indicated that only three out of 21 firms reported that the replacement value of their capital stock

exceeded $500,000. At the other extreme, 4 reported that their capital stock was estimated to be valued at less than $6000.

As shown in Table 3, fence posts are the most important product of the post and pole sector in terms of volume of production. The obvious substitutes for wooden fence posts are metal posts. Barbed wire and woven fence can replace wooden rails and some lumber and metal products can be substituted for structural roundwood products. There is little evidence of brand preference operative in the post and pole sector just as there is little or no brand preference for lumber products. Thus, the presence of substitutes for post and pole products suggests the presence of a competitive industry.

Domination of an industry by a few firms suggests something less than perfect competition. Figure 1 illustrates graphically that production in the Montana post and pole industry is highly concentrated. The straight line drawn at a 45 degree angle represents a hypothetical line showing the distribution of production if all firms were equal in size. The lower, curved line represents the actual distribution of production for the post and pole sector. The distance between the two lines indicates the relative degree of concentration of ownership of production. Thus, the graph shows that the smallest 60% of post and pole producers are responsible for 20% of the total volume produced in the state. In contrast, the top two of the 21 firms account for almost two-thirds of all post and pole production. While no comparable production data are available for the solid wood products industry in the state, it would appear that the "big two"

CONCENTRATION of MANUFACTURING of POSTS AND POLES IN MONTANA

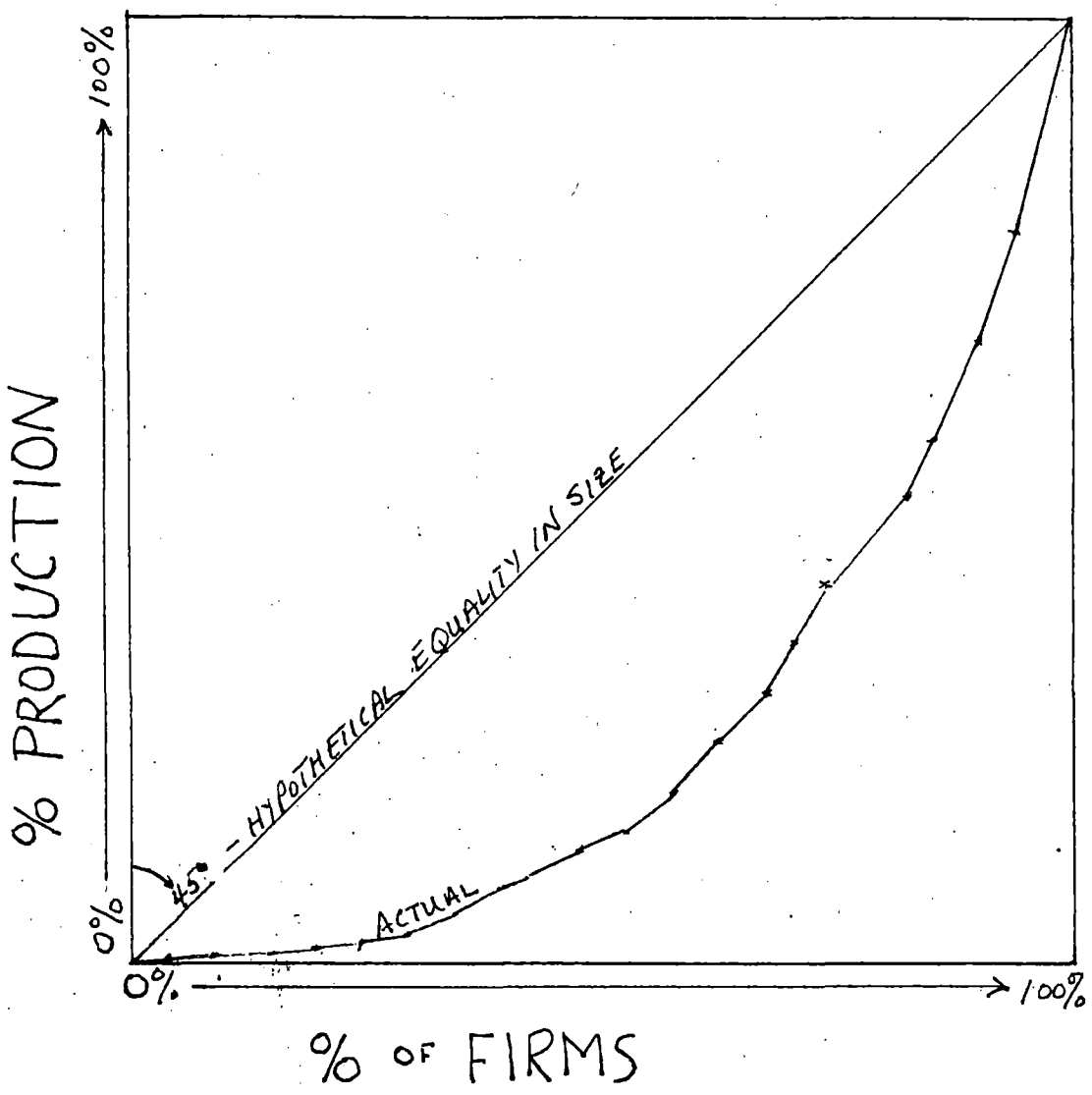


FIGURE 1

(Champion and Plum Creek) are somewhat less dominant than their counterparts in the post and pole sector.

Although Montana's production is quite concentrated, the market for post and pole products is not confined within the state's borders. Manufacturers in Montana face competitors throughout the west. An unknown quantity of post and poles are imported to the state. Thus, while production within the state may be concentrated, a competitive market prevails within the larger post and pole sector, and there is evidence to suggest that Montana's producers participate in that larger market.

D. Current Markets and Channels of Distribution

Information obtained from the survey made it possible to determine the geographic distribution of roundwood markets for Montana post and pole producers. All of the firms sell their products within the state except one, and it reported no sales in-state. As shown in Table 4, the combined volume of shipments from all producers to purchasers within Montana constitutes 45% of the total volume. The California/Nevada market accounts for the second largest volume of shipments (19.6%) followed by Wyoming/Colorado and the Dakotas/Nebraska (13% each).

In addition to the geographic destination of products, the firms were asked to identify the type of purchaser for their products, specifically, the end user, wholesale distributor, or retail outlet. As shown in Table 5, wholesale purchasers comprise 43.5% of the estimated buyers of products. End users bought 34.5% and retail outlets purchased 21.1% of total volume produced.

Table 4
Destination of Shipments from Montana Post and Pole Producers

State	Volume, cubic ft.	Percent Total Production
Montana	1,335,576.2	43.5
Pacific Northwest	16,338.6	.5
California/Nevada	602,016.2	19.6
Wyoming/Colorado	414,384.3	13.5
Arizona/New Mexico	20,526.0	.7
Dakotas/Nebraska	405,180.6	13.2
Midwest	27,611.9	.9
Oklahoma/Texas	79,247.7	2.6
Canada	50,538.1	1.6
Other/unknown	122,367.1	3.9
TOTAL	3,073,786.7	100.0

Table 5
Purchasers of Roundwood Products

Type of purchaser	Volume, cubic ft.	Percent Total Production
End user	1,059,781.6	34.5
Wholesale	1,335,956.6	43.5
Retailer	648,304.8	21.1
Other/unknown	29,743.7	.9
TOTAL	3,073,786.7	100.0

An assessment of market demand for roundwood products was conducted by means of a question (see Appendix A, Question 14) addressed to producers listing a variety of factors which might affect product sales. They were asked to indicate how important they perceived each item to be and a weighted index of response was

developed based on an assignment of numerical values for the degree of importance of each item. Table 6 summarizes the responses.

Table 6
Factors Affecting Product Sales

Item	Score*	Index of Relative Importance**
Freight rates	19	45.2
Geographic location of plant	22	52.3
Economic health of agribusiness	35	83.3
Housing construction	13	30.9
Advertising	11	26.2
Competition with foreign imports	1	2.3
Availability of export markets	1	2.3
Highway and public works	18	42.9

*Sums of scores assigned for great deal of importance (2); some importance (1); no importance (0).

**Aggregated score divided by total possible score if all scores were 2's.

The weighted scores indicate that producers perceive their markets to be most affected by the economic health of agribusiness. The geographic location of their plant was the second major item of importance to the level of sales, closely followed by freight rates and highway/public works construction.

E. Raw Materials

The firms surveyed were asked to indicate the source of their raw materials in terms of volume of receipts by ownership class. Forest Service, state, private, and other publically administered (including tribal) lands were the ownership categories used.

Table 7 shows that the Forest Service and privately owned lands constituted two thirds of the source of raw materials. Most firms relied upon a mixture of private and Forest Service sources of raw materials, but five were solely reliant on one or the other.

Table 7
Source of Raw Materials

Owner	Volume, cubic ft.	Percent Total Production
Forest Service	1,087,608.7	35.4
State	127,436.1	4.1
Private	959,340.5	31.2
Other Public	878,842.1	28.6
Other	20.559.3	.7
TOTAL	3,073,786.7	100.0

Producers included in the study were asked if they had any problems acquiring raw materials for their plant within the last five years. Twelve out of 20, or 60% of the firms surveyed reported some difficulty obtaining raw materials. It is of some note that nine of those firms expressing problems obtained 50% of more of their raw material from Forest Service lands.

The most frequently cited reason for problems in obtaining logs was difficulty in finding people willing to cut and deliver materials at competitive prices. Unavailability of timber and red tape were given as reasons by over half of the respondents.

F. Firm Size and its Relationship to Marketing Channels and to Source of Raw Materials

As was indicated earlier in the discussion on competition among firms, there appears to be a fair amount of concentration in the post and pole industry in Montana. A relevant line of inquiry is directed towards the issue of marketing channels and raw materials sources as they relate to firm size. For purposes of this analysis, the post and pole producers were divided into quartiles with cut-off points based on production volume.

Table 8 presents data on sales of products within Montana and outside the state. The picture of the industry that emerges from these data show dramatic differences in geographic markets between the large and small firms. Thus, while 47% of the total volume of all sales takes place within Montana, only 25% of the volume of large producers is marketed in-state. Small producers sell almost exclusively to Montana purchasers.

Table 8
Geographic Markets by Firm Size

Firm Size*	Product Destination**			
	Inside Montana		Outside Montana	
(Quartiles)	Volume	% 0-sales	Volume	% 0-sales
Top	481,822.9	(25)	1,348,948.1	(75)
Second	522,863.5	(69)	233,535.5	(31)
Third	357,773.7	(93)	46,707.1	(7)
Fourth	73,116.1	(94)	5,062.0	(6)
Subtotal	1,435,576.2		1,615,843.5	
% Total	(47)		(53)	
		TOTAL 3,051,419.7		

*Based on total cubic ft. volume produced as follows: Top (>200,000) Second (200,000-100,000), Third (99,000-45,000), Fourth (<45,000)

**Only known product destinations included.

In addition to the geographic markets, purchaser types were related to firm size, using the same quartiles. The results displayed in Table 9 suggest that the smaller firms sell to end users to a considerably greater extent than do the five largest producers of posts and poles. Two-thirds of the volume of the largest five producers is sold to wholesale distributors. Overall, sales to retail outlets constitutes the smallest volume of sales for all groups of producers.

Table 9
Channels of Product Distribution by Firm Size

Firm Size	Purchaser*					
	End User		Wholesaler		Retailer	
(Quartiles)	Volume	% Q-sales	Volume	% Q-sales	Volume	% Q-sale
Top	298,950.5	(16)	1,229,253.0	(64)	384,728.9	(20)
Second	468,301.1	(61)	61,662.3	(8)	236,897.4	(31)
Third	241,030.4	(84)	45,041.4	(16)	none	(0)
Fourth	51,499.6	(66)	none	(0)	26,678.5	(34)
Subtotal	1,059,781.6		1,335,956.7		648,304.8	
% Total	(35)		(44)		(21)	

TOTAL 3,044,043.1

*Only known purchasers included in table.

A final analysis of firm size concerned the source of their raw materials. Table 10 provides a summary of the data which indicates that while lands administered by the Forest Service are the source of one third of all raw materials, the five largest producers are far less reliant upon this source than the smaller producers.

Table 10
Source of Raw Materials by Firm Size

Firm Size* (Quartiles)	Ownership Category* Forest Service Volume	% 0-total	Private Volume	% 0-total	Other Public Volume	% 0-total
Top	229,895.2	(12)	769,291.6	(40)	907,156.0	(48)
Second	601,110.2	(78)	128,702.2	(17)	37,048.2	(5)
Third	207,198.7	(69)	32,573.2	(11)	62,074.0	(21)
Fourth	49,404.6	(63)	28,773.5	(37)	none	(00)
Subtotal	1,087,608.7		959,340.5		1,006,278.2	
% Total	(36)		(31)		(33)	
		TOTAL	3,053,227.4			

*Only known sources included in table.

G. Cross-Sectional Analysis of Raw Material and Finished Product Prices

The previous discussion of diverse finished products sizes and prices in the post and pole sector indicated that a method of summarizing prices was needed for this study. Ideally, prices should involve a unit of volume measurement of wood, such as cubic feet. However, all post and pole yards buy raw materials from cutters based on measures of small-end diameter. The same is true for product prices. Manufacturers sell posts, poles and rails of various lengths and small-end diameters with no standard system of size classes or prices.

In order to aggregate prices for raw materials and finished products, it became increasingly apparent that a statistical price equation, incorporating diameter and length as variables, would be useful. Regression analysis was used to obtain summary coefficents for raw material prices. Tables 11, 12 and 13 represent price

estimates for three length classes of raw materials delivered to the yards of the manufacturers.

It should be noted that 13 producers complied with our request for a current price lists for both raw materials and products. In total, there were 134 observed raw material prices from these respondents. Small-end diameters included on the raw material or "cutters" price lists ranged from 2.00 to 7.5 inches. Lengths ranged from 5.33 to 30.5 feet.

Table 11 presents the results of a model which predicts the unit price (price per piece) for short lengths of delivered roundwood (5.33 to 10 feet). These lengths are generally associated with fence posts, tree props or grape stakes. Tables 12 and 13 represent price estimates for the medium and long length classes of raw materials.

It was found that segmenting reported prices into three length classes resulted in better explanatory equations than would have been the case with ungrouped data. Specification of independent variables was identical for the three size classes. Each equation uses a curvilinear measure, the exponential of length in feet, which indicates that price per piece increases at a decreasing rate for longer lengths. A "volume" type variable DsqL, using small-end diameter (D) measured in inches multiplied by length (L) measured in feet, serves as a proxy for cubic volume.

Estimates for product prices were determined using a similar method. The 13 firms which submitted prices for products are again the foundations for the post, pole and rail price equations.

Table 11
Price Equation for Short Length Raw Materials*

Variable Name	Regression Coefficient	t-ratio
constant	.1799	
Dsq L	.0027	16.1399
exp length	1.16210e.05	4.3806

R Square = .8441 n = 62
Adjusted R Square = .839 F(2,59) = 159.6925
Standard Error as a % of mean Y (unit price) = 19.39%

* Lengths = 5.33 thru 10.0 ft.

Table 12
Price Equation for Midlength Raw Materials**

Variable Name	Regression Coefficient	t-ratio
constant	.3604	
Dsq L	.0039	23.2011
exp (length)	1.59146e.08	6.1619

R Square = .9466 n = 48
Adjusted R Square = .9442 F(2,45) = 398.7845
Standard Error as a % of mean Y (unit price) = 14.54%

**Lengths = 10.1 thru 18.0 ft.

Table 13
Price Equation for Long Length Raw Materials***

Variable Name	Regression Coefficient	t-ratio
constant	.7943	
Dsq L	.0056	9.8806
exp (length)	1.30432e.13	2.0701

R Square = .8753 n = 24
Adjusted R Square = .8634 F(2,21) = 79.693
Standard Error as a % of mean Y. (unit price) = 79.69%

***Lengths = 18.1 thru 30.5 ft.

There were over 1000 observed prices indicative of the size, length, treatment and other processing (i.e., peeling, pointing, drilling, doweling). A systematic 10% sample of the post, pole and rail prices was taken from these price lists.

Table 14 below presents the model for post prices. Due to basic size similarities, other products like grape stakes are included in the data used for this equation. The upper length for posts included was artibrarily set at ten feet.

Table 14
Price Equation for Post Lengths under 10 feet

Variable Name	Regression Coefficient	t-ratio
constant	.1009	
Drilled; yes=1	.9643	2.4731
Dsq L	.0128	12.1774
SAT	.1165	3.6997

R Square = .8460 n = 41
Adjusted R Square = .8335 F(3,37) = 67.7407
Standard Error as a % of mean Y (unit price)= 23.305%

The Dsq L variable represents the same volume type measure utilized in the raw material price equations. Since some posts are fully treated and others are butt treated, it was assumed that the product price would reflect the surface area treated (SAT). Cylindrical measure was used as a proxy for surface area. Thus, the variable SAT was estimated using the small-end diameter in feet (D/12) multiplied by the length (L) of the piece actually being treated times the constant, Pi [(D/12)(L)( )].

The other variable in the price equation for posts, drilled, is a dummy variable where a value of one was assigned if the post had holes drilled in it for doweled rails. The sample included both two and three-hole posts. Other variables for pointed/unpointed and peeled/unpeeled characteristics were not statistically significant and were eliminated from the final equation.

Tables 15 and 16 below represent the models for short and long poles. Short poles ranged from 10.1 through 16 feet in length and long poles ranged from 16.1 to 30.5 feet. The variables in the two pole equations are defined as in the previous discussion.

Table 15
Price Equation for Short Poles - 10.1 thru 16.0 feet

Variable Name	Regression Coefficient	t-ratio
constant	-.5836	
Dsq L	.0177	15.5705
SAT	.2328	4.8531

R Square = .9185 n = 31
Adjusted R Square = .9127 F(2,28)= 146.5035
Standard Error as a % of mean Y (unit price) = 24.86%

Table 16
Price Equation for Long Poles - 16.1 thru 30.5 feet

Variable Name	Regression Coefficient	t-ratio
constant	-.0942	
Dsq L	.0170	5.0874
SAT	.2034	4.3556

R Square = .8142 n = 14
Adjusted R Square = .7804 F(2,11)= 24.0968
Standard Error as a % of mean Y (unit price) = 23.43%

The estimated price equation for rails is in Table 17. Rails were defined as reported on producers' price lists. They are similar in length to posts and poles (as small as 8 ft. in length) and may be as large as 20 feet in length. Some rails are treated and others are not. Some are doweled on the ends although doweling usually increases the price of a rail by less than fifty cents and was not a significant variable.

Table 17
Price Equation for Rails

Variable Name	Regression Coefficient	t-ratio
constant	-.0942	
Dsq L	.0170	5.0874
SAT	.1797	4.3556

R Square = .8203 n = 22
Adjusted R Square = .8014 F(2,19) = 43.3606
Standard Error as a % of mean Y (unit price) = 37.08%

The final statistical price model presented is for wooden gates. Gates differ in terms of length, number of rails, and whether or not the rails are peeled. All prices are for both unassembled and assembled gates. Table 18 presents the summary for the gates equation. Gate lengths ranged from 4 to 16 feet and the number of rails from two to six. The price equation is based upon 46 price-product observations, as only six of the producers reported gate prices.

Table 18
Price Equation for Gates (Unassembled)

Variable Name	Regression Coefficient	t-ratio
constant	-0.1198	
Length	2.4297	9.3993
# Rails	1.2630	1.4675
Peeled, 1=yes	-1.7824	.4062
Peeled*length	-0.4774	1.5415
Peeled*rails	2.6043	2.7537

R Square = .9089 n = 47
Adjusted R Square = .8978 F(5,41) = 81.7865
Standard Error as a % of mean Y (unit price) = 9.04%

Finally, miscellaneous post and pole products and their average prices, computed directly from price lists suppled by manufacturers, are in Table 19.

Table 19
Miscellaneous Product Prices

Product	Unit Price
Peeled jack-leg posts (dowelled and drilled)	$ 3.57
Unpeeled jack-leg psts (dowelled and drilled)	$ 2.39
Haystack panels (16 ft. lengths)	$15.50
Portable corrals (12 and 16 ft., peeled and unpeeled)	$24.75

H. Value Added by Manufacturing--Some Examples

The equations developed for raw material prices and the for the sale price of products, FOB producers yard, can be used to estimate value added by manufacturing beyond the cost of raw materials. Table 20 gives examples for selected products.

Table 20
Value Added by Manufacturing

Product	Volume cu. ft.	Purchase Price per unit	Purchase Price per ft3	Product Price per unit	Product Price per ft3	Value Added per unit	Value Added per ft3
6.5'x 4" top fence post, 3' treated, no holes	.64	.47	.73	1.80	2.81	1.33	1.48
12' x 3" top rail untreated	.78	1.06	1.36	2.35	3.01	1.29	1.65
15' x 6" top pole untreated	3.55	2.52	.71	8.97	2.53	6.45	1.82
15' x 6" top pole full treatment	3.55	2.52	.71	14.46	4.07	11.94	3.36

Using the fence post as a standard product (6.5'x 4" top), the producer pays about $ .47/post for raw material delivered to the yard, or $ .73/ft3. After peeling, pointing, capping and treating a three foot butt portion, the post is sold for $1.80 at the yard or about $2.81/ft3. Value added in manufacturing for capital, labor and preservatives is $1.33/unit, or about $1.48/ft3. The other entries in the table are self explanatory.

The main factor affecting value added/ft3 is the application of preservatives. Most post and pole manufacturers specify the delivery of green lodgepole logs. This is apparently designed to reduce preservative costs as dead lodgepole would absorb considerably greater amounts of preservative. Also, application of the preservative Penta, requires vats of various lengths, as well as additional amounts of

labor and production time. Without preservatives, the value added by manufacturing runs about $1.75/ft3.

V. Estimating Raw Material Demand

A. An Outline of Approaches

Post and pole manufacturers in Montana purchase raw materials of particular diameter/length specifications from independent cutters at advertized prices, delivered to their yards. Post and pole producers, with limited exceptions, do not engage in logging operations nor in transportation of logs to their mills. Thus, delivered logs are one factor of production and the problem at hand is to estimate the demand for a productive factor.

The problem of demand estimation is approached via two alternative methodologies. First, the raw material demand function is approached from the estimation of a production function. Given a production function, and the assumption of competitive resource allocation, the demand for a factor can, in turn, be estimated (see Walters 1963) for an excellent discussion of the problems and approaches in statistical production functions).

Another less conventional approach to the estimation of derived demand for raw materials is also presented. Recreation demand estimates are often based on surveys, particularly questions about willingness to pay. The questionnaire used in this study was designed to develop demand estimates for raw materials from producers in much the same way.

B. The Production Function and Implied Nature of Derived Demand

In general, a production function specifies the quantifiable relationship between imputs in the production process such as capital, labor and raw materials and the number of outputs produced. In equation form, the production function is stated as:

$$Q = f(K, L, N)$$

where: Q = output produced
K = amount of capital
L = amount of labor
N = amount of raw materials

The methodological problem apparent in post and pole manufacturing is the overwhelming relationship between Q, the output measure, and N, the input measure. A fence post is almost exactly the same volume measure of output as is N, the same raw material volume measure of input (see Rao and Miller 1971), for a discussion of overwhelming variables).

As a result of the overwhelming relationship between Q and N, an alternative specification of the production function, where N is left out, was developed. As will be shown later, inferences regarding the demand for raw materials are still possible due to the fixed relationship between Q and N. The revised production function is specified as follows:

$$Q = f(K, L)$$

As in all production studies, the definition and measurement of capital (K) can be elusive (Walters 1963). The questionnaire evoked responses for the technical production capacity of each product per eight hour shift. These capacity figures were converted to annual

capacities by assuming 50 producing weeks per year. Then a ratio of actual annual production over capacity multiplied by the reported capital stock value was used to measure capital utilization. Labor was measured by the average annual number of employees reported in the phone survey. Natural logs of all the variables including output were then calculated and resulted in the following statistical model.

Table 21
Production Function Equation

Variable Name	Regression Coefficient	t-ratio
constant	10.13	
ln capital	1.09	6.23
ln labor	.01	.222

R Square = .794 n = 19
Adjusted R Square = .768 F(2,16) = 27.0226
Standard Error as a % of mean Y (total ln ft3 produced) = 5.89%

Taking antilogs of the above model, it can be re-expressed as:

$$Q = 10.13K^{1.09}L^{.01}$$

Note that the exponents in the above equation sum to a value of 1.10 which is slightly greater than 1. This indicates increasing returns to scale (see Silberburg, 1978). The idea of increasing returns to scale is not consistent with stable firm size or stable firm and industry equilibrium. In addition, capital as specified is not significant and is correlated with labor in the magnitude of $R = .51$

An alternate production function using the original Cobb-Douglas model where the exponents are restricted to a sum of one was estimated for the data. This restricted model is consistent with constant returns to scale. The Cobb-Douglas production function is presented in Table 22.

Table 22
Cobb-Douglas Production Function Equation

Variable Name	Regression Coefficient	t-ratio
constant	10.17	
ln L/K	.979	15.809

R Square = .9434 n = 19
Adjusted R Square = .9401 F(1,17) = 249.9098
Standard Error as a % of mean Y (ln ft3 produced/K) = 35.66%

The second model appears to be a "better" fit than the first model without the restriction. With fewer independent variables, both the unadjusted and adjusted R Square values are higher and the overall F level improved substantially. A statistical test was conducted to determine whether differences in the two models were significant (see Koutsoyiannis 1977). In other words, should the result showing increasing returns to scale, a finding not consistent with economic theory, be accepted rather than the model of constant returns to scale. The computed F =.4537, was not great enough to reject the constant returns to scale model and thus was accepted as the better estimate of the production function for the post and pole sector.

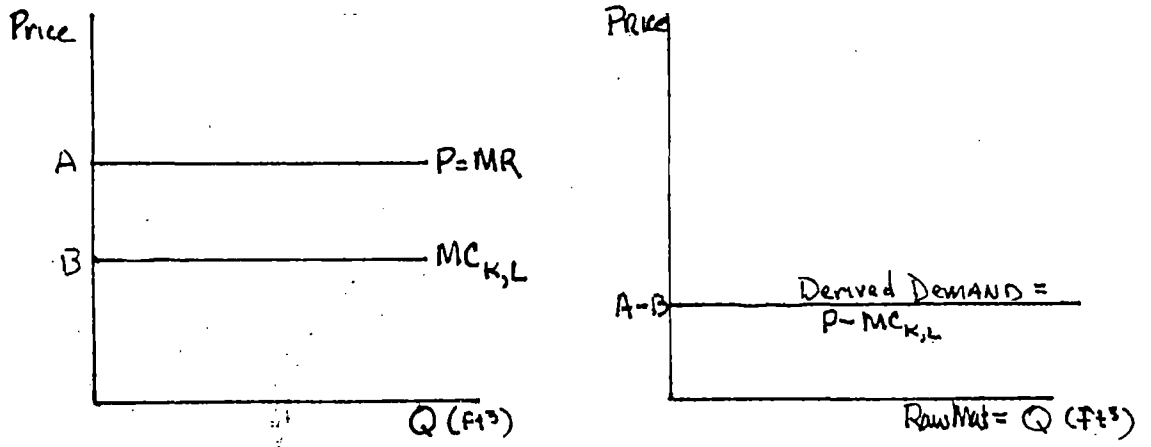
By rearranging variables and taking the antilogarithm, the

the empirical production function is:

$$Q = 10.17K^{.979}L^{.021}$$

Given the fixed quantitative relationship between the raw material input and product output, the conclusion of constant returns to scale of capital and labor means that marginal costs are constant over the observable levels of production since there are no economies of scale.

The constant marginal cost function for the representative, or typical firm in the industry, leads to inferences about the price elasticity of demand for raw materials. Figure 2 presents a graphic illustration of the relationship between marginal cost and demand for raw materials.



The Firm's Demand, Marginal Cost of Capital and Labor, and Derived Demand for Logs

Figure 2

In Figure 2, the product price is represented by the line where Price = Marginal Revenue (MR) and the constant Marginal Cost function is depicted as $MC_{K,L}$. The derived demand for the raw materials under conditions of fixed input-output proportions is simply Price minus $MC_{K,L}$. This, too, is a horizontal firm demand function for raw materials. Thus, if the firms demand for raw materials is perfectly elastic for given capital costs, labor costs and product prices, the aggregation of demand for the Montana post and pole sector should also be perfectly elastic.

C. Raw Material Demand Based on Willingness to Pay

The second approach to estimating the price elasticity of demand for raw materials involved use of data from the survey. During the interviews, each respondent was asked how production would change in response to a 10% increase in raw materials prices. Given the fixed relationship between raw material inputs and production outputs, the results of this question can be useful for developing an alternative estimate of the derived demand for raw materials.

Responses were given by product and were aggregated for the firms included in the study. Overall, the response to a 10% increase in raw materials prices, (assuming product prices and employee wages did not change), was a 15.19% decrease in output. It is inferred that there would be an equal decrease in the purchase of raw materials. Thus, using the willingness to pay approach, the predicted price elasticity of demand for raw materials is -1.52.

D. Conclusions Regarding Demand for Raw Materials

Both the estimate of price elasticity based on the production

function and that based on willingness to pay suggest that demand is price elastic. The question may arise as to why the measures of elasticity have such a broad range.

It appears that during the year the post and pole sector was studied, firms were operating far below their productive capacity. An estimate of utilization of capital based on questions about the firm's 8-hour capacity indicated an exceptionally low utilization of capital. Important product markets in agribusiness and public highway construction were very depressed during this period. Thus, it may be that the finding of constant returns to scale was the result of low levels of production rather than the technical relationships between inputs and outputs observable during more normal levels of production. The conclusion of constant returns to scale seems highly tenative along with its corollary that constant marginal costs yield a perfectly elastic price elasticity of demand for raw materials.

VI. Market Supply of Post and Pole Products

The results of the production function and the associated marginal cost curve for the representative post and pole firm shown in Figure 2 lead to some logical inferences about the aggregate short-run supply function for the Montana post and pole industry. The perfectly elastic MC function for the competitive firm suggests a perfectly elastic short-run industry supply function. Of course the short-run supply function assumes constancy in the number of firms, factor prices and technology.

As was the case in estimating raw material demand, the questionnaire was used to develop an alternate measure of supply. Respondents indicated how much they would change production if there were a 10% increase in product prices, given production costs did not change. The aggregate response was an increase in volume of 646,823 ft3, or a 19.72% change. This translates to an estimate of price elasticity of supply of 1.97 since elasticity is simply the percentage change in quantity demanded divided by the percentage change in price. Thus, both approaches to the estimation of price elasticity of supply yield consistent results that indicate the supply of post and pole products is price elastic.

VI. Conclusions

If a goal of forest land management is to increase the opportunities to utilize small diameter lodgepole pine, the results of this study suggest a variety of means to accomplish this end.

First, judging by the nature of the production function estimated by this study, constant returns to scale do not seem to limit firm size. Rather, the individual firm and the post and pole sector as a whole, are limited by the size or extent of the market for their products. The largest firms ship more of their products out-of-state, both in absolute and in relative terms, than do the smaller firms. Further, the out-of-state markets are characterized by different marketing channels than the in-state market. The top quartile of producers primarily sell to wholesalers rather than end-users, as is the case with smaller firms. It is of note that about one out of every

five cubic feet of post and pole products manufactured in the state is shipped to the California/Nevada area.

Second, the most significant external force which influences demand for post and pole products is the economic health of agribusiness. The short-term prospects for many components of agriculture are affected by changes in the value of the U.S. dollar relative to foreign currencies and to the structure of production costs of American goods relative to those of other nations. The long-term outlook for American agriculture is likely to be brighter if densely populated countries (particularly in the Pacific Rim) acquire more wealth and increase their demand for agricultural products.

The problems of freight rates and location will continue to nag Montana producers. This will be particularly true of lower-priced products since an increment in freight costs per cubic foot increases the price of these goods at destination relative to the delivered price of higher-priced products. Thus, firms with wood preservative facilities may be better candidates for expansion than those without that capability as treated products command higher prices in the marketplace.

Third, the results of this study indicate that the national forests are not the primary source of raw materials for the post and pole sector in Montana. Even though 60% of Montana's total forest lands available for timber harvesting are in Forest Service ownership, post and pole producers reported receiving only 35% of their raw materials from this source. The largest producers in the state

are the least reliant on the national forest which suggests that their suppliers of raw materials operate in a different supply arena than those who sell to smaller firms.

Fourth, the analysis of raw material demand and product supply suggests that purchases and production levels are both quite sensitive to price. Demand for raw materials is price elastic. There is also price elasticity of supply for roundwood products.

A wide variety of raw material prices and products prices were observed within the post and pole industry. The main reason for so many differenct prices is the myriad sizes of products available. However, using the method of regression analysis, price equations were produced which provide reasonably accurate estimates of prices for the sector as a whole. These equations suggest that the value of the raw materials and products are highly uniform given allowances for size variation and/or other product characteristics such as treatment with preservative. This uniformity in price indicates that Montana is at least a component of some larger market area. Since market areas can be distinguished as regions with uniform price, it appears that submarkets do not exist within the state. The raw material and product price equations are good predictors because of the geographic uniformity of value.

In summary, a body of new information has been provided about the post and pole industry in Montana. The nature of the firms, mix of products, competitiveness of markets, channels of distribution, structure of costs, and prices of raw materials and products have been described in detail. This sector is often overlooked because

it operates at the periphery of the larger, solid-wood products industry. However, it demonstrates the successful utilization of small diameter timber as a primary raw material by at least one sector of the wood products industry.

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Appendix A
QUESTIONNAIRE

ESTIMATION OF DEMAND FOR ROUND WOOD PRODUCTS

Instructions:

1. Ask to speak to the mill operator.
2. Introduce self.

My name is _____, I am employed on a research project under the direction of Professor David Jackson of the School of Forestry at the University of Montana.

3. State purpose.

I would like to ask you some questions that will take about 10 to 15 minutes of your time to answer. All of the information which you provide will be held in strict confidence and no information will be divulged for an individual mill. The data collected will be summarized and used for an analysis of Lodgepole pine markets in Montana. We feel this is an important study and your cooperation is essential in obtaining complete information.

4. Proceed with item 4, page 2. Complete this cover sheet at end of interview.

****

1. Plant Name_____

2. Address_____

_____

3. Name of person interviewed_____

Title_____

Date of Interview_____

4. I am going to read a list of equipment and I would like you to tell me which of the following are used in your operation.

Equipment	Used	Not Used
* Doweler		
* Pole Shaver (Peeler)		
Butt Vats		
Full Length Vats		
Incizers		
Framing		
Mortising Drill		
Pointer		
Pressure Cylinder		
Cutoff saws		
Other		

5. After considering normal maintenance and down-time what is the estimated capacity per eight-hour shift of your plant in 1985? Also, please give annual total estimates for each of the products you manufactured last year.

Product	Unit of Measurement	Capacity 8-Hour	(Past 12 months) Annual Total
Posts	No. of pieces		
	Average length		
	Average diameter		
Poles	No. of pieces		
	Average length		
	Average diameter		
Pilings/ Util. Poles	Thousand bd. ft.		
Barn Poles	Thousand bd. ft.		
Timbers	Thousand bd. ft.		
Rails	*		
Prop Poles/ Grape Stakes	*		
Decorative Fencing	*		
Mining Props	*		
Other	*		

*To be specified by respondent.

6. Please summarize the shipments of finished wood products from your plant in 1984 by volume, geographic destination and type of purchaser, (e.g., end user, wholesale distributor, retail outlet).

(NOTE: USE CODE LIST TO ENTER RESPONSES FOR GEOGRAPHIC DESTINATION AND TYPE OF PURCHASER.)

Product	Volume	Destination (% by code)	Purchaser (% by code)

7. Now I am going to ask you about the source(s) of your raw materials. Please indicate the volume of receipts in percentage terms for each owership category.

What percent of the total volume of receipts are from: (NOTE: READ DOWN LIST OF OWNERS).

Volume of Receipts (%)	Owner
	Forest Service
	BLM
	State
	Tribal lands
	Private
	Other

8. What is your average annual total (including full and part-time) employment?

_____

9. What is your average annual payroll (including benefits)?

_____

10. The following question asks you to speculate about future sales and costs of raw materials. Please think of your estimates in percentage terms.

a. If you could sell your products for a 10% higher price next year, and your production costs didn't change, how would the quantitites sold of your various products change?

Product	% Change	(Current Capabilities) Yes	No

Would you be able to meet increases in sales with current capacity? (NOTE: CHECK OFF ABOVE.)

b. If your raw material costs went up 10% next year and your product prices and employee wages did not change, would your purchases of raw materials increase, decrease, or stay the same?

By what percentage would the purchases change?

---

11. Do you have any immediate plans to acquire new manufacturing equipment?

11.a IF YES:

I am going to read a list of reasons why you may be purchasing new equipment. Please indicate the primary reason for your purchase. (NOTE: "IF MORE THAN ONE TYPE OF PURCHASE SPECIFY SEPARATE REASON FOR EACH PURCHASE).

_____ to manufacture a new product

_____ to increase productivity of labor

_____ to increase productivity in use of raw materials

_____ to increase capacity of existing operations

_____ replace worn or old equipment

_____ other (specify)

12. If your plant were to be insured against <u>total loss</u>, what is the approximate replacement value you would estimate for your plant and equipment, including vehicles?

_____

13. Have you had any problems in acquiring raw materials for your plant in the last five years?

_____

13a. IF YES:

I am going to read a list of reasons why it may be difficult to acquire raw materials. Please choose the explanation that best fits your circumstances.

_____ unable to find people willing to cut and deliver at competitive prices

_____ timber is not available (name ownership source_____)

_____ timber is available but is too costly

_____ there is too much red tape in acquiring timber

_____ other (specify)

14. I am going to read a list of factors which affect product sales. As I read each item, indicate whether you think it has a <u>great deal</u> of importance, <u>some</u> importance or <u>no</u> importance in your current level of sales.

Item	Great	Some	No
	IMPORTANCE		
Freight rates			
Geographic location of plant			
Economic health of agribusiness			
Housing construction			
Advertising			
Competition with foreign imports			
Availability of export markets			
Highway and public works construct.			
Other			

This concludes the interview. It would be most helpful for the completion of this study if you would send a list of your product prices and a list of prices for raw materials delivered to your yard to:

David Jackson
School of Forestry
University of Montana
Missoula, Montana 59812

THANK YOU FOR YOUR COOPERATION.

****

Geographic destination codes:

11 Washington, Oregon, Idaho
12 California, Nevada
13 Wyoming, Utah, Colorado
14 Arizona, New Mexico
15 Dakotas, Nebraska, Kansas
16 Minnesota, Michigan, Wisconsin, Ohio, Indiana, Illinois, Iowa, Missouri
17 Oklahoma, Texas
18 Southern states excluded above
19 Eastern States excluded above
20 Montana

Type of purchaser codes:

01 End user
02 Wholesale distributor
03 Retail outlet
04 Other

Note: If the mill has both a doweler and a pole shaver, ask the following!

We are interested in comparing production rates of the doweler and the pole shaver. Could you tell us the production rates for the two machines?

	Pieces per 8-hr shift	Annual Total
Shaver	_____	_____
Doweler	_____	_____